



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
-----------------	-------------	----------------------	---------------------	------------------

10/706,773

11/12/2003

Edward Barth

FIS920010293US 2

7726

7590

11/03/2004

Margaret A. Pepper  
International Business Machines Corporation  
2070 Route 52  
Hopewell Junction, NY 12533

EXAMINER

VU, HUNG K

ART UNIT

PAPER NUMBER

2811

DATE MAILED: 11/03/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 10/706,773	<b>Applicant(s)</b> BARTH ET AL.	
	<b>Examiner</b> Hung Vu	<b>Art Unit</b> 2811	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 15-33 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 15-33 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |   |  |
|---|--|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)  | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)            |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>11/12/03</u> . | 6) <input type="checkbox"/> Other: ____  |

## DETAILED ACTION

### *Drawings*

1. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the method further comprising a silicon nitride film on the hardmask layer and a silicon oxide film on the silicon nitride film, as recited in claim 21, must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

***Claim Objections***

2. Claim 26 is objected to because of the following informalities: In claim 26, lines 2-3, “a conductive material” should be changed to “the conductive material” for clarity. Appropriate correction is required.

***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 15 – 20, 26 – 28 and 30 – 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (PN 6,727,176) in view of Gabriel et al. (PN 6,475,929). Ngo et al. discloses, as shown in Figures 2-4 a method for forming an interconnect structure on a substrate, the method comprising the steps of:

depositing a dielectric layer (23,24,25) , the dielectric layer being formed of a carbon-containing dielectric material having a dielectric constant of less than about 4 [Col. 5, line 47 – Col. 6, line 9];

forming an opening in the dielectric layer;

filling the opening with a conductive material (27), thereby forming a conductor, the conductor having a surface coplanar with the top surface of the dielectric layer layer;

exposing the conductor to a reducing plasma comprising at least one gas selected from the group consisting of H<sub>2</sub>, N<sub>2</sub>, NH<sub>3</sub> and noble gases [Col. 6, lines 10 – 54];

depositing silicon nitride (40) on the conductor by a plasma-enhanced chemical vapor deposition (PE CVD) process, thereby forming a silicon nitride cap layer (40) [Col. 5, líneas 25 – 29].

Ngo et al. does not disclose depositing a hardmask layer on the dielectric layer. However, Gabriel et al. discloses a method of forming an interconnect structure comprising depositing a hardmask layer (150) on a dielectric layer (140). Note Figure 3 of Gabriel et al.. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the structure of Ngo et al. having a hard mask layer depositing on the dielectric layer, such as taught by Gabriel et al. in order to protect the dielectric layer from the process that remove a subsequently formed resist layer and to prevent damage to the dielectric layer during subsequent polishing away of conductive material deposited over the dielectric layer.

With regard to claim 16, Ngo et al. and Gabriel et al. disclose the hard mask layer is formed of silicon nitride, and is deposited by a chemical vapor deposition (CVD) process [Col. 9, lines 6 – 10].

With regard to claim 17, Ngo et al. and Gabriel et al. discloses all of the claimed limitations except material of hardmask layer. However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the device of Ngo et al. and Gabriel et al. having the materials as that claimed by Applicant, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

With regard to claims 18-20 and 33, although Ngo et al. and Gabriel et al. do not teach the process of exposing the conductor to a reducing plasma at a flow rate, a RF power, a temperature, or to a pressure in the reactor, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the conductor exposing to a desired flow rate, RF power, temperature, or pressure, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

With regard to claim 26, Ngo et al. and Gabriel et al. disclose the method further comprising the step of depositing a conductive liner (26) in the opening prior to filling the opening with the conductive material.

With regard to claim 27, Ngo et al. and Gabriel et al. disclose the method further comprising the step of depositing an adhesion promoter layer (22) on the substrate prior to depositing the dielectric layer.

With regard to claim 28, Ngo et al. and Gabriel et al. disclose the dielectric layer is formed of an organic thermoset polymer having a dielectric constant of about 1.8 to about 3.5 [Col. 5, line 47 – Col. 6, line 9].

With regard to claims 30 – 32, although Ngo et al. and Gabriel et al. do not teach the composition of the silicon nitride film or the silicon oxide film, as that claimed by Applicants,

Art Unit: 2811

however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the silicon nitride film or the silicon oxide film having a desired composition, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

4. Claims 15-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (PN 6,727,176) in view of Kudo (PN 6,420,261, of record).

Ngo et al. discloses, as shown in Figures 2-4 a method for forming an interconnect structure on a substrate, the method comprising the steps of:

depositing a dielectric layer (23,24,25), the dielectric layer being formed of a carbon-containing dielectric material having a dielectric constant of less than about 4 [Col. 5, line 47 – Col. 6, line 9];

forming an opening in the dielectric layer;

filling the opening with a conductive material (27), thereby forming a conductor, the conductor having a surface coplanar with the top surface of the dielectric layer;

exposing the conductor to a reducing plasma comprising at least one gas selected from the group consisting of H<sub>2</sub>, N<sub>2</sub>, NH<sub>3</sub> and noble gases [Col. 6, lines 10 – 54];

depositing silicon nitride on the conductor by a plasma-enhanced chemical vapor deposition (PE CVD) process, thereby forming a silicon nitride cap layer (40) [Col. 5, lines 25 – 29].

Art Unit: 2811

Ngo et al. does not disclose depositing a hardmask layer on the dielectric layer. However, Kudo discloses a method of forming an interconnect structure comprising depositing a hardmask layer (55) on a dielectric layer (54). Note Figures 3P, 4G and 8P of Kudo. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the structure of Ngo et al. having a hard mask layer depositing on the dielectric layer, such as taught by Kudo in order to protect the dielectric layer from the process that remove a subsequently formed resist layer and to prevent damage to the dielectric layer during subsequent polishing away of conductive material deposited over the dielectric layer.

With regard to claims 16 and 17, Ngo et al. and Kudo discloses all of the claimed limitations except material of hardmask layer. However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the device of Ngo et al. and Gabriel et al. having the materials as that claimed by Applicant, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

With regard to claims 18-20 and 33, although Ngo et al. and Kudo do not teach the process of exposing the conductor to a reducing plasma at a flow rate, a RF power, a temperature, or to a pressure in the reactor, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the conductor exposing to a desired flow rate, RF power, temperature, or pressure, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).



With regard to claim 21, Ngo et al. and Kudo disclose the method further comprising the step of:

depositing a silicon nitride film (61) on the hardmask layer;

depositing a silicon oxide film (63) on the silicon nitride film.

With regard to claims 22 – 25 and 30 – 32, although Ngo et al. and Kudo do not teach the composition or the pressure of forming the silicon nitride film or the silicon oxide film, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the silicon nitride film or the silicon oxide film having a desired composition or pressure, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

With regard to claim 26, Ngo et al. and Kudo disclose the method further comprising the step of depositing a conductive liner (26) in the opening prior to filling the opening with the conductive material.

With regard to claim 27, Ngo et al. and Kudo disclose the method further comprising the step of depositing an adhesion promoter layer (22) on the substrate prior to depositing the dielectric layer.

Art Unit: 2811

With regard to claim 28, Ngo et al. and Kudo disclose the dielectric layer is formed of an organic thermoset polymer having a dielectric constant of about 1.8 to about 3.5 [Col. 5, line 47 – Col. 6, line 9].

With regard to claim 29, Ngo et al. and Kudo disclose the dielectric layer is formed of a polyarylene ether polymer.

***Conclusion***

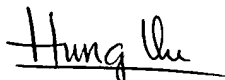
5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hung K. Vu whose telephone number is (571) 272-1666. The examiner can normally be reached on Mon-Thurs 6:00-3:30, alternate Friday 7:00-3:30, Eastern Time.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on (571) 272-1732. The Central Fax Number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Vu

October 28, 2004



Hung Vu

Patent Examiner